Carrageenan: A Safe Additive

As the general secretary of Marinalg International, an association representing the worldwide producers of carrageenan, I would like to comment on Tobacman's review article in *EHP* (*1*).

Authorities worldwide have extensively reviewed carrageenan safety. Contrary to Tobacman's conclusion (*1*), all of these authorities agree that carrageenan may be used safely in food. As recently as June 2001, the Joint FAO/WHO Expert Committee on Food Additives (JECFA; an independent international panel of expert scientists and government authorities) concluded a multiple year review of all of the relevant safety data on carrageenan (*2*). This included a specific analysis of the potential for promotion of colon cancer by carrageenan. The JECFA affirmed their earlier conclusion on the safety of carrageenan [e.g., (*3*)]—that it may be used safely in the diet at amounts only limited by the amount necessary to achieve its technical function. Overall, the carrageenan sold as a food, drug, and cosmetic additive has been tested extensively, and regulatory authorities worldwide have uniformly found carrageenan to be essentially nontoxic and agreed that it may be used safely in food.

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Carrageenan: Response

It is difficult to recognize a wolf in sheep's clothing. This seems to be the situation with regard to carrageenan.

In response to a letter to *EHP* from Phil Carthew, I commented on some of the data used for the recent Joint FAO/WHO Expert Committee on Food Additives (JECFA) review to which Kirsch refers (*1,2*). I found the JECFA conclusions disconcerting in view of the available evidence. Previously, the JECFA considered modification of their recommendation about carrageenan to include a minimum average molecular weight (*3,4*).

Extensive experimental data have demonstrated that *a*) degraded carrageenan produces neoplasms and ulcerations in animal models; *b*) acid hydrolysis, such as occurs in the stomach, leads to the production of degraded carrageenan from food-grade carrageenan; and *c*) food-grade carrageenan contains significant amounts of degraded carrageenan. Human consumption of carrageenan has been increasing steadily in the United States in the 20th century (*5–8*).

The data with regard to intestinal effects of carrageenan seem sufficient to mandate restriction of carrageenan intake. I remain hopeful that the Food and Drug Administration and the JECFA will revise their recommendations pertaining to the safe use of carrageenan, that industry will substitute other gums for carrageenan, that red seaweed farmers will diversify, and that consumers will select food products without carrageenan.

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Public Fear of Dioxins from Modern Municipal Waste Incinerators Is Not Justified

In spite of the important increase of the three "r's" (reduction, reuse, and recycling) in the management of municipal solid waste (MSW), there are still many places in which incineration continues to be an important option for the disposal and treatment of MSW. Although incineration recovers energy and reduces the volume of waste that requires landfilling, because it also involves the emission of a number of pollutants where incinerators are used or proposed, people are often afraid that resulting pollutants will adversely affect their health. Concern has been especially notable with respect to dioxins and furans. These organic pollutants are toxic in extremely tiny amounts and bioaccumulate in humans (*1–5*). Moreover, in February 1997 using recent epidemiologic data on exposed human populations and experimental carcinogenicity bioassays in laboratory animals, the International Agency for Research on Cancer (IARC) classified 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (TCDD) as carcinogenic to humans (IARC group 1) (*6*). Recent episodes such as the Belgian PCB and dioxin incident of 1999 (*7,8*) have contributed to increase the concern with respect to dioxins.

As a direct consequence of a notable growth in the public opinion against the binomial MSW incineration and dioxins, numerous municipal, regional, and national governments have placed a moratorium on construction of new MSW incinerators (MSWIs) and more stringent controls on existing units. The argument against incineration of MSW is mainly based on the following premises: MSWIs emit dioxins, and dioxins are carcinogenic; therefore, MSWIs are carcinogenic facilities. However, in recent years, dioxin emissions from MSWIs have been reduced to levels < 0.1 ng I-TEQ/Nm^3. As a consequence of this, the current national dioxin inventories show that in those countries with a stringent regulation of dioxin emissions from MSWIs (e.g., the member states of the European Union) that started legislation in the early 1990s, MSW incineration is currently a minor contributor to any national inventory (*9,10*).

Taking the above information into account, the main purpose of this letter is to try to abate the fear of dioxins in relation to MSWIs, especially for the population living near these facilities. To reduce total dioxin exposure, a simple change in the dietary habits can be as relevant as the decrease in direct exposure to environmental dioxins in the vicinity of a MSWI. The data shown in Tables 1 and 2 are based on studies from two MSWIs in Catalonia, Spain, in which technical improvements were recently carried out and dioxin emissions were reduced to concentrations < 0.1 ng I-TEQ/Nm^3 (*11,12*). To assess human health risks before and after these improvements, the following routes of dioxin exposure were evaluated: direct contact from inhalation of

Table 1. Comparison of the reduction in direct exposure to dioxins with a single change of dietary habits: consumption of 300 g/day semi-skimmed milk instead of whole milk.

	Whole milk	Semi-skimmed milk	Reduction
Dioxin concentrations in milk (pg I-TEQ/g wet weight)	0.011	0.006	0.005
Dioxin intake through milk consumption (pg I-TEQ/kg bw/day)	0.047	0.026	0.021

Table 2. Dioxin exposure for adult populations living at 500 and 1,000 m from two municipal waste incinerators (MSWI-1 and MSWI-2) before and after pronounced reductions in the emissions of dioxins from the facilities.

	MSWI-1				MSWI-2			
	500 m		1,000 m		500 m		1,000 m	
	Before	After	Before	After	Before	After	Before	After
Total direct exposure (pg I-TEQ/kg/day) x 10^{-2}	5.102	1.271	4.087	0.995	2.085	0.466	1.721	0.439
Reduction in total direct exposure (pg I-TEQ/kg/day)	0.038		0.031		0.016		0.013	
Dietary intake (indirect exposure) (pg I-TEQ/kg/day)	2.770	0.903	2.770	0.903	2.790	0.907	2.79	0.907
Total exposure to dioxins (pg I-TEQ/kg/day)	2.82	0.92	2.81	0.91	2.81	0.91	2.81	0.91

air and particles; ingestion and dermal contact with soil and dust; and indirect exposure (dietary intake). For risk estimations, I assumed the worst scenario (e.g., all dioxins in the neighborhood of the respective MSWI would be emitted by the facility).

For adults living at 500 m from MSWI-1 (Montcada), the direct exposure to dioxins before technical improvements was 5.102 × 10^{-2} pg I-TEQ/kg/day, and the total dioxin exposure was 2.82 pg I-TEQ/kg/day. This resulted in a contribution to dioxins from the MSWI of 1.81%. Two years after technical improvements were carried out, direct exposure to dioxins decreased to 1.271 × 10^{-2} pg I-TEQ/kg/day, while the total dioxin exposure diminished to 0.92 pg I-TEQ/kg/day, which results in a contribution to dioxins from the MSWI of 1.36%. This indicates that the important percentage reduction (75.1%) in the direct exposure to dioxins is practically imperceptible when compared with the contribution of indirect exposure (dietary intake) to total dioxin exposure, which decreased from 2.82 (*13*) to 0.92 pg I-TEQ/kg/day (*12*) during the same period.

Although people are concerned about exposure through MSWI emissions, diet is the main route of dioxin exposure in humans. With respect to this, the absolute reduction of 0.038 pg I-TEQ/kg/day in the dioxin levels at 500 m from the MSWI-1 2 years after introducing the technical improvements is of the same order of magnitude as a simple change in dietary habits: daily consumption of 300 g of semi-skimmed milk instead of the same quantity of whole milk would result in a reduction in dioxin exposure of 0.021 pg I-TEQ/kg/day (dioxin concentrations in semi-skimmed and whole milk of 0.006 and 0.011 pg I-TEQ/g wet weight, respectively; Table 1). Similar results would be also obtained for those living at 1,000 m from the facility (total reduction from direct exposure of 0.031 pg I-TEQ/kg/day). For adult subjects living at 500 and 1,000 m from MSWI-2 (Tarragona), the decreases in direct exposure to dioxins were 0.016 and 0.013 pg I-TEQ/kg/day, respectively (Table 2), values that are also similar in magnitude to the reduction of 0.021 pg I-TEQ/kg/day derived from a hypothetical consumption of semi-skimmed milk instead of whole milk (Table 1).

For a number of different reasons, strong arguments in favor or against incineration as a way of disposal and treatment of MSW can be justified. However, it seems quite evident that the public concern over the health risks due to exposure to dioxins emitted by modern MSWIs or MSWIs equipped with modern technologies is not scientifically justified. Therefore, decisions regarding the construction or closing of modern MSWIs should not be primarily based on public opinion and fears of dioxin emissions from these plants. Because the diet is the main route of human exposure to dioxins, only efforts to reduce emissions from all sources can significantly contribute to decrease environmental dioxin concentrations, and consequently, their levels in food.

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Corrections and Clarifications

In the article "High-Resolution Revolution" [*EHP* 110: A238–239], the units of measurement in the article listed as millimeters should be micrometers. Also, in the photo caption on p. A239, the scan image on the computer, which is identified as rat tissue, is from a mouse. *EHP* regrets the errors.